Cords for installation in barns should be made of cotton and be 3/32-3/16 inch in diameter. The larger size is necessary with diazinon, but either size is satisfactory with parathion. Cords should be treated by dipping in 5% or 10% parathion-xylene solution or 25% diazinon-xylene solution. After drying, the cords are strung along the ceiling or rafters of barns at the rate of 30 linear feet per 100 square feet (9 m per 9 m^2) of floor area. Usually the cords will provide effective control for 7-11 weeks and in many cases for an entire fly season.

Extreme care must be taken in preparing and handling dipping solutions and treated cords. Experienced personnel can safely impregnate cords, but it is advisable for most users to purchase a commercial product. Cotton gloves should be worn while the cords are being installed. At the end of the fly season, it is advisable to remove and burn or bury the cords.

Cords have been registered for use in dairy barns in the USA.

The Toxicity of Three Organic Phosphorus Insecticides to Houseflies and Mosquitos*

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The development of strains of mosquitos and houseflies resistant to chlorinated hydrocarbon insecticides has intensified the interest shown in the insecticidal properties of other groups of chemicals, especially organic phosphorus compounds. A number of phosphorus insecticides with a comparatively low degree of mammalian toxicity have become available recently, and the relative toxicities of three of them to houseflies and some mosquito species have been determined.

Materials and methods

Test insects. Breeding was carried out by standard methods at 25°C, and the following adult insects were used :

Musca domestica L. : 3-4-day-old females, fed on milk.

Aëdes aegypti L. : 2-3-day-old females, a few hours after the first blood meal on guinea-pigs.

Culex pipiens molestus Försk (London strain): 1-2-day-old, unfed females, reared from eggs obtained from females fed on apple and sugar.

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Anopheles stephensi List.: 2-3-day-old females, a few hours after the first blood meal on guinea-pigs.

Anopheles quadrimaculatus Say.: 2-3-day-old females, a few hours after the first blood meal on guinea-pigs.

Anopheles gambiae Giles (normal Lagos strain): 1-2-day-old females, a few hours after the first blood meal on guinea-pigs. The majority of females fed at this age, and some deaths occurred if they were starved for 2-3 days.

Housefly pupae averaged 24 mg in weight, and average weights of 1-2-day-old unfed female mosquitos were as follows: *Aëdes aegypti*, 2.10 mg; *C.p. molestus*, 4.05 mg; *A. stephensi*, 1.50 mg; and *A. gambiae*, 0.98 mg.

Insecticides. The following insecticides were used:

Chlorthion, supplied by Farbenfabriken Bayer for Baywood Chemicals Ltd., and contained 99.6% active ingredient 0,0-dimethyl 0-(3-chloro-4-nitrophenyl) phosphorothioate.

Diazinon, supplied by the Geigy Company Ltd., and contained 90% active ingredient 0,0-diethyl 0-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate.

Malathion, supplied by the American Cyanamid Co., and contained 95.6% active ingredient 0,0-dimethyl S-(1,2 diethoxycarbonylethyl) phosphorodithioate.

Each insecticide was applied in solution in kerosene (Regent Company burning oil).

Application of insecticide. A measured volume of insecticide solution was applied to the dorsal surface of the thorax of each insect from a microburette. Volumes of from 0.022 μl to 0.045 μl of a 0.25% solution of diazinon gave the required range of kills of houseflies, but larger volumes of up to 0.135 μl of 1% malathion and 0.25% chlorthion solutions were necessary as their limited solubility prevented the use of more concentrated solutions. Similar volumes of solvent alone caused no deaths among controls. Preliminary experiments determined the concentration of each insecticide required to give a range of kills after the application of volumes of from 0.010 μl to 0.036 μl to mosquitos.

Two batches of 15 insects were treated at each of three or four dosages of each insecticide. Tests with all three insecticides against a given species were carried out on the same day. After treatment each batch of insects was placed in a wire-gauze cage at 25°C and 70%-80% relative humidity. Median lethal doses were calculated from the mortalities recorded 24 hours after treatment. No further deaths occurred after this interval.

Results

Median lethal doses and relative potencies of the three phosphorus insecticides to the different insects are given in Table I.

The numbers of *A. quadrimaculatus* available at one time were insufficient for the determination of the median lethal doses of three insecticides,

TABLE I. DOSAGE AND MORTALITY DATA AND RELATIVE POTENCIES OF CHLORTHION, DIAZINON AND MALATHION

Insect	Insecticide	Slope of regression line and standard error	LD_{50} (μg per insect)	95 % fiducial limits	Relative potencies (diazinon standard)
M. domestica	Chlorthion		ca. 0.33 *		0.23
	Diazinon	10.82 ± 2.41	0.077	0.071 — 0.083	1.00
	Malathion	12.38 ± 1.78	0.77	0.73 — 0.82	0.10
Aëdes aegypti	Chlorthion	9.76 ± 1.86	0.0039	0.0036 — 0.0042	3.64
	Diazinon	9.73 ± 1.80	0.0142	0.0131 — 0.0153	1.00
	Malathion	8.06 ± 1.94	0.0061	0.0054 — 0.0067	2.32
C. p. molestus	Chlorthion	8.42 ± 1.33	0.0059	0.0055 — 0.0063	4.20
	Diazinon	8.47 ± 1.46	0.0248	0.0230 — 0.0274	1.00
	Malathion	8.91 ± 1.80	0.0120	0.0111 — 0.0131	2.07
A. stephensi	Chlorthion	7.41 ± 1.25	0.0081	0.0074 — 0.0087	0.49
	Diazinon	8.48 ± 2.03	0.0040	0.0036 — 0.0043	1.00
	Malathion	9.12 ± 1.96	0.0056	0.0051 — 0.0062	0.71
A. gambiae	Chlorthion	8.94 ± 1.29	0.0019	0.0018 — 0.0021	1.74
	Diazinon	8.81 ± 1.30	0.0033	0.0031 — 0.0035	1.00
	Malathion	7.41 ± 1.64	0.0028	0.0026 — 0.0030	1.18

* Not calculated. highest dosage gave 53 % kill.

and it was possible only to compare the toxicity of diazinon and chlorthion at one dosage. At a dosage of 0.009 μg per mosquito, 63 % of 38 females were killed by diazinon, whereas none of the 38 females treated with chlorthion died.

Median lethal doses of chlorinated hydrocarbon insecticides determined for some of these species are given in Table II for comparison.

Discussion

The three organic phosphorus insecticides used have a comparatively low degree of mammalian toxicity. Metcalf [a] quotes the following acute oral LD_{50} values in mg per kg of body-weight to rats: parathion, 6-15; diazinon, 220-270; chlorthion, 1500; malathion, 1400-5834.

Their relative toxicity to insects varied from one species to another. They can be arranged in the following order of decreasing toxicity to adult female houseflies (*M. domestica*): diazinon > chlorthion > malathion.

[a] Metcalf, R. L. (1955) *Organic insecticides—their chemistry and mode of action*, London

TABLE II. MEDIAN LETHAL DOSES OF CHLORINATED HYDROCARB ON INSECTICIDES

Insect	DDT	Gamma-BHC	Dieldrin
M. domestica	0.320	0.080	0.022
Aëdes aegypti	0.018	0.0038	0.0047
C. p. molestus	0.085		
A. stephensi	0.018	0.0019	0.0019
A. gambiae			0.0010

The toxicity of chlorthion was approximately the same as that of DDT, while diazinon was 10 times as toxic as malathion. MacCuaig (personal communication) puts the three compounds in the same order of toxicity to locusts *Schistocerca gregaria* Försk and *Locusta migratoria migratorioides* R and F. Lewallen[b] also found the same order of toxicity to the common housefly but found that chlorthion was more toxic than either diazinon or malathion to the little housefly *Fannia canicularis* L.

The three phosphorus compounds were more toxic than DDT to mosquitos. They can be arranged in order of decreasing toxicity to two culicine mosquitos, *Aëdes aegypti* and *C. p. molestus*, as follows: chlorthion $>$ malathion $>$ diazinon. *C. p. molestus* was less susceptible than *Aëdes aegypti* to all three compounds and also to DDT. Lindquist[c] refers to experiments by Gjullin in which *Culex tarsalis* (Coq.) females were exposed to residues on glass for one hour. Malathion and chlorthion at 0.5 mg per square foot produced mortalities of 48% and 54% respectively, while diazinon at 2 mg per square foot caused 51% mortality.

On the other hand, the decreasing order of toxicity to *A. stephensi* was diazinon $>$ malathion $>$ chlorthion, and diazinon was shown to be more toxic than chlorthion to *A. quadrimaculatus*. These results suggested, therefore, that chlorthion may be more toxic than diazinon to anophelines. However, when tests were carried out with another anopheline, *A. gambiae* (normal Lagos strain), it was found that the order of toxicity of the three insecticides was in fact the same as for the two culicine species. It is concluded, therefore, that the relative toxicity of the organic phosphorus compounds to mosquitos varies considerably from one species to another.

[b] Lewallen, L. L. (1954) *J. econ. Ent.*, **47**, 1137

[c] Lindquist, A. W. (1957) *Bull. Wld Hlth Org.*, **16**, 33